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Polyperiod Analyses of Investment Strategy for Nebraska Grain-Livestock Farms

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SUMMARY

This study was directed at the growth process of a representative eastern Nebraska grain-livestock farm. The analysis emphasized optimal long-term investment strategies. The investment analysis related to form, timing and use of land investments and investments in livestock facilities.

Polyperiod linear programming models were developed to determine optimal investment and operating strategies. Each model incorporated a 20-year time period with the objective of maximizing discounted net returns.

The basic model has initial resource levels of 320 acres of land, $10,000 of capital and 2,080 hours of operator labor. Four thousand hours of hired labor were assumed available. It was assumed that the firm withdrew $15,000 annually from the capital to pay fixed costs and living expenses. Fixed costs increased in relation to acquired cropland.

It was assumed that the firm initially had no livestock facilities. A restriction was that the operator could borrow no more than $50,000 of short-term capital in any one year or more than 50 percent of his equity, whichever was less. Land was assumed to have a $300 per acre capital requirement or security level.

Annual cropping activities competed for the land resource. In addition, cropland could be purchased with financing of two-thirds of the capital requirement through a 15-year mortgage. Four cattle feedlot investments were included as activities which differed in their capital-labor requirements. These feedlot investments had various lengths of useful life. Similarly, conventional and confinement swine facilities were included as investment activities. While both swine investment activities had 10-year life terms (includng financing) the facilities differed in resource use and production efficiency. Annual cattle and hog activities were included to utilize the livestock investments.

The first phase of the analysis analyzed the effect of resource levels on optimal growth patterns. Model I was the basic model encompassing the above basic restrictions. Results indicated relatively large conventional swine investments early in the period. Production of hogs declined over time as capital was generated. Cattle feedlot capacity increased through time as did acquired cropland. Before the mid point of the 20 years the results stabilized with 1134 head of cattle and 759 acres of cropland.

In Model II initial capital levels were set at zero instead of $10,000. Little effect on the results was noted except for higher levels of swine investments and use early in the period for purposes of capital generation.

In Model III, labor was not permitted to be hired. This change greatly affected the results, deleting hogs from the solution and restricting the growth of the cattle feeding enterprise and land acquisition.

Finally, Model IV examined the effect of reducing initial land ownership to 80 acres. While this decrease restricted activity very early in the period, the pattern of very high hog production and increasing land acquisition emerged, accompanied by a delayed cattle feeding activity. In all models except III the growth patterns "matured" at the same levels of cattle feeding and owned cropland.

A change in product prices characterized the second phase of the analysis. In Model V, resource restrictions were the same as Model I. However, livestock prices were 2-3 percent lower than Model I while crop prices remained the same. The results of the relative decrease in profitability in livestock compared to cash crop production were evident when results of Model V were compared to results from Model I. Cattle feeding investments and activities dropped from the solution in Model V and were replaced by increased land purchases. The role of swine was even greater than in Model I with the major swine investments in the confinement facilities. Swine, therefore, retained its role as a capital generation instrument.

The final phase of this analysis evaluated the firm growth process under cyclical livestock prices. Under particular investigation was the consequence of cyclical livestock prices upon livestock investments. A dual-purpose or flexible livestock investment activity was added as an activity in this section. A recurring 10-year cattle price cycle and 5-year hog price cycle was substituted for the constant livestock prices of previous models. Model VI employed as a starting point high cattle prices and low hog prices. In Model VII, initially low prices for both cattle and hogs were chosen as a starting point of the 20-year period. In both models resource restrictions were the same as for Models I and V.

Results of the two cyclical-price models indicate that only a slight to moderate investment timing strategy occurs in response to the cyclical livestock price assumptions. Similar organizational patterns emerge compared to the constant-price Model V (the average of the cyclical livestock prices in Models VI and VII equal the constant livestock prices of Model V). Cattle feeding did not enter the solutions to Models VI and VII, hence no response to the cattle price cycle was observed. Swine investment remained specialized.

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Glenn A. Helmers, Gary W. Lentz[1]

INTRODUCTION

Little research has been directed at quantifying the crucial elements in the farm firm growth process. The nature of capital accumulation in agriculture is a complex and dynamic economic process complicated by risk and uncertainty. Due to the rapidly changing structure of agriculture, specific information is needed about farm financial operations and resource use which contribute to a growth environment. Likewise, analysis of the timing and form of durable investments as they relate to firm growth is needed.

Farm firm growth is built upon capital accumulation which is dependent upon the initial mix and level of existing farm resources. Farm family consumption patterns form capital withdrawals influencing the capital accumulation process. The firm growth process is accomplished through investments by increasing physical size or output. Capital for such investments is secured through internal withdrawals or from external financing. Thus, the timing and form of durable capital investments and the financing of such establishes an important body of research of the farm firm growth process.

OBJECTIVES

This study is directed toward investment strategies farm firms in the Great Plains may utilize to achieve their individual goals. Farm firm growth is considered important to the extent that firm growth represents movement toward meeting the behavioral goals of farm operators.

Previous models of this type have attacked the problem of growth accomplishment using a variety of objective functions to represent goals of the farm operator. Some of these have been:

1. Maximize terminal net worth.
2. Maximize capital (cash) withdrawals to pay living expenses.

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3. Maximize discounted (and undiscounted) net returns.

4. Maximize gross sales.

A study by Martin and Plaxico (10) indicates that maximizing discounted net returns resulted in the same capital accumulation pattern as did maximizing gross sales, maximizing undiscounted net returns, maximizing ending owned capital and maximizing acres of land operated. Boehlje and White (2) found that optimal growth decisions differ between the use of net worth and disposable income as objective functions.

This study analyzes growth patterns using an objective function of maximizing discounted (6%) net returns for a 20-year planning period. Objectives of this study are:

1. To establish the optimum growth pattern (enterprise organization and investments) over time of a typical eastern Nebraska grain-livestock farm firm.

2. To determine optimal strategies for orderly growth when the levels of starting land and capital are limited and the alternative of hiring labor is restricted.

3. To prescribe optimal strategies for growth under different expected product prices.

4. To compare growth patterns when the planning horizon is of constant pricing compared to cyclical variations in price (for beef and hogs).

5. To determine impact of cyclical variations in beef and hog prices upon flexible and specialized livestock investments.

The emphasis of this study lies in determining optimal farm investment strategy. Investment strategy in farm planning can be analyzed only by taking into account the time-related processes whereby investments are related to the farm resource mix and restrictions, short-run organization plans and the timing and sequence of such investments over a period of time. These aspects are incorporated in the model used in this study.

Seven polyperiod linear programming models were developed to analyze study objectives. Four models were investigated under varied resource restrictions of the firm. A fifth model was run at different product price assumptions. Models VI and VII employed cyclical price patterns for hogs and beef and incorporated a flexible investment alternative not included in Models I through V.

RESEARCH MODEL

This study is an application of the mathematical optimizing technique of linear programming. The model used in this study is polyperiod linear programming which is an extension over time of linear programming.

The General Linear Programming Problem

The standard problem of linear programming is to maximize a linear objective function, subject to a series of resource restrictions and subject to the requirement that activity levels are non-negative.

Algebraically we may write:

Maximize:

$$z = \sum_{j=1}^{n} c_j \, x_j,$$

Subject to:

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \quad (i = 1, \ldots n)$$

and

$$x_{j-} \geq 0 \quad (j = 1, \ldots n)$$

where the matrix of a_{ij}'s represents the input-output coefficients, x_j is the vector of activities, (the level of each is established in the optimal solution), c_j is a vector of returns or costs associated with each activity, b_i is a vector of available resources, and z is the functional value to be maximized.

With the use of matrix notation, the problem is to find a matrix (vector) X, which maximizes $z = C'X$,

$$\text{subject to } AX \leq B$$
$$X \geq 0.$$

As in all linear programming problems the further assumptions on additivity, proportionality, and divisibility are assumed to hold.

Polyperiod Linear Programming

The extension of linear programming to the polyperiod model can be described using matrix and vector notation. If the standard linear programming matrix of input-output coefficients is given by A, then the polyperiod matrix for n periods can be represented as a partitioning of A into:

$$A = \begin{bmatrix} A_{11} & & \\ A_{21} & A_{22} & \\ \cdot & \cdot & \\ \cdot & & \cdot \\ A_{n1} & \cdots & A_{nn} \end{bmatrix}$$

where $A_{nn} = A_{n-1n-1}$.

Each submatrix $A_{11} \ldots A_{nn}$ is a matrix of input-output coefficients produced and consumed in each time period. Rows and columns of each submatrix overlap other submatrixes. Overlapping rows implies that some commodities produced during one time period could be used in the production of some commodity in a succeeding period or periods. For example, owned land used in period one may also be used in succeeding time periods. Overlapping columns implies that products (or returns) generated in time period one could also be used in the production of commodities in succeeding time periods.

The B vector of the polyperiod linear programming model is considered to be a series of subvectors, each of which is associated with one of the submatrixes A. The B vector for the polyperiod model may be written as

$$B = \begin{bmatrix} B_1 \\ B_2 \\ \cdot \\ \cdot \\ \cdot \\ B_n \end{bmatrix}$$

Each subvector of B represents the resources of the firm available in each time period, for example, land or owned labor.

The cost-return vector C′ is a series of subvectors exactly comparable to the vector of B values. The C′ vector for the polyperiod model may be written:

$$C' = [C_1, C_2, \ldots C_n]$$

where each subvector $[C_1 \ldots C_n]$ is associated with each time period in the model.

The entire polyperiod linear programming model may be written as follows:

Maximize:

$$z = [C_1, C_2, \ldots C_n] \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_n \end{bmatrix}$$

Subject to:

$$\begin{bmatrix} A_{11} & & & \\ A_{21} & A_{22} & & \\ \cdot & \cdot & & \\ \cdot & & \cdot & \\ \cdot & & & \cdot \\ A_{n1} & \cdot & \cdot & \cdot \; A_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_n \end{bmatrix} \leq \begin{bmatrix} B_1 \\ B_2 \\ \cdot \\ \cdot \\ \cdot \\ B_n \end{bmatrix}$$

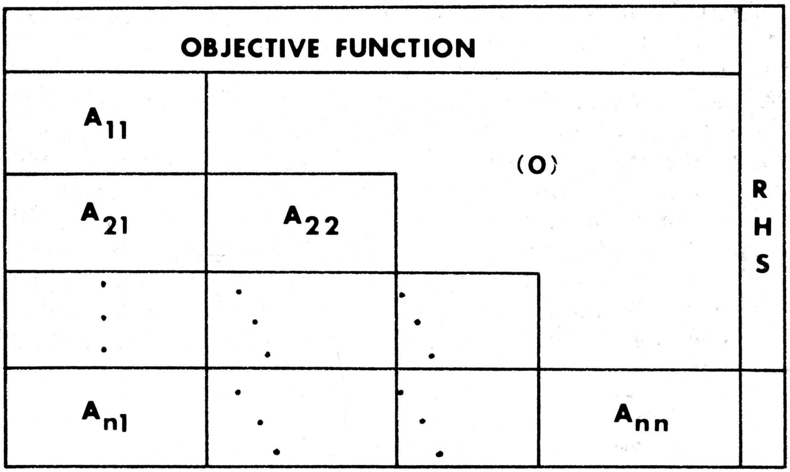

Figure 1. Pictoral representation of the constant-price polyperiod linear programming model where right hand side is the original resource vector.

And:

$$\begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_n \end{bmatrix} \geq 0$$

The matrix of input-output coefficients may be termed a block triangular matrix. This means that the A matrix considers those elements to the left of and including the main diagonal. All elements to the right of the main diagonal are zero. A diagrammatic representation of the entire matrix is presented in Figure 1. The large size of the entire matrix (481 rows by 657 columns) makes its inclusion impractical.

The polyperiod model may be considered dynamic internally, but from an external viewpoint it is static. The model is dynamic because it depicts a series of optimal resource organization positions corresponding to each year's annual organization, time is involved in the planning horizon and resources and products are transferred from period to period. Externally the entire model is static because the coefficients and relationships between them do not change, are known with certainty and there are no outside forces affecting the model. That is, the model is a 20-year slice of time.

PREVIOUS POLYPERIOD MODELS OF FIRM GROWTH

Early polyperiod linear programming farm firm models stressed enterprise organizational patterns which contributed to firm growth (11, 9). Later models were developed to analyze more fully the external capital market (6, 5). Most models which have included investment analyses have confined the investments to land expansion alternatives and land financing (10, 1). Johnson provided for stochastic yields in his model, a departure from the usual constant price and yield assumptions (8). A study which includes livestock investment activities, all of which are assumed to have a 10-year life, was published by Boehlje and White (2). That study allowed unused capital assets to be sold.

This study differs from the above studies in:

1. The inclusion of more periods in the model.
2. The consideration of varied term livestock investment activities.
3. The employment of price cycles in hogs and beef.
4. The provision for varied-term specialized livestock investments and flexible livestock investment activities.

Flexible livestock facilities, while less technically efficient than specialized facilities, have a potential economic advantage under wide product price movements (3).

REPRESENTATIVE MODEL AND SITUATION

Representative Farm

The representative farm is a hypothetical firm whose organizational structure is representative of the Great Plains. The figures used are hypothetical. However, figures are believed to be similar to many farm firms operating in the area. Technical coefficients such as hours of labor per acre and others were compiled from a variety of sources and publications (7, 12, 13).

The firm has a starting size of 320 acres. The initial assumption is that the land is entirely owned, thus giving the operator full equity. Furthermore, the assumption is made that the operator is starting the year with $10,000 of capital. This starting capital (cash) is assumed to be a carryover from operations the previous year. The farm operator has 2,080 hours of labor to devote to the operation. The firm has no livestock facilities. Livestock activities must be a result of new investments in facilities. The firm is currently withdrawing $15,000 annually from the capital stream to pay fixed and living expenses. The assumption is also made that the operator fully owns equipment to operate the initial crop acreage and for some expansion.

Because of a desire for risk aversion it is assumed that the operator cannot borrow more than $50,000 of short-term capital in any one year or not more than 50 percent of any equity he may have, which ever is less. Also, because of limited ability to manage labor, the operator is restricted to hiring no more than 4,000 hours of labor annually.

The land is assumed to have a value of $300 per acre, thus giving the operator $96,000 in security starting in the first year. Land values are not assumed to appreciate since technical coefficients of production remain static. Renting is not considered as a method of expanding the land base in this model.

Objective Function

The objective function for this model is one that maximizes discounted net returns. Discounting is used because a dollar received in the future is worth less than one today. The formula for expressing the present value of a future amount is:

$$PV = \frac{F}{(1+i)^n}$$

where PV is the present value, F is the future value, i is the interest rate, and n is the number of years.

The interest rate for this problem is 6 percent. All objective function values are discounted to their present value in year 1 beginning with year 2.

Activities

Activities in the polyperiod model are established as in single period analyses through a budgeting procedure. The only difference lies in that production activities can extend over more than one period.

This polyperiod model contains four cropping activities for each year–growing corn (GCRN), growing corn for silage (GCNS), growing soybeans (GSYB), and growing alfalfa (GALF). A growing pasture activity (PAST) can also be developed to utilize cropland if that choice optimizes the solution.

The assumption that the operator is unwilling to manage more than two additional men forces an annual limitation of 4,000 hours in hiring labor (HLBR). Labor is assumed to cost $2.00 per hour and becomes available for any activities that may require it. Given the relatively large availability of labor which could be hired (4,000 hours), a moderately low level of operator labor (2,080 hours) is assumed available.

Activation of the land purchase activity (BLNM) allows the farm firm to expand its land base. Land purchased is assumed to be immediately available for productive use and is assumed to have a value (capital requirement) of $300 per acre. Land value is based upon 1965–70 average land values of dryland farms in the eastern one-half of Nebraska. Crop prices and yield ($1.10 per bushel and 85 bushels per acre for corn, for example) reflect conditions underlying the assumed land value. The farm operator may secure financing for two-thirds of the capital requirement with a 15 year mortgage. The first year requires the down payment of $100 plus the first payment of the amortized repayment schedule. There is also assumed to be a $4 per acre title and transfer fee associated with each acre purchased. The interest rate in the amortized repayment schedule is 8 percent.

The objective function entry for this activity is the "cost" to the firm of acquiring an acre of land. These "costs" are the total interest on the mortgage ($150.40) plus taxes at $4 per acre per year ($80) discounted to a total of $162.90. The total cost is not the purchase price because land is not a depreciable item. Therefore, the capital requirement is not the same as the entry for the objective function.

It is further assumed that fixed capital must increase as the land base expands. This fixed capital cost increase can be assumed to be taxes at the rate of $4 per acre and an additional machinery investment of $7 per acre to maintain the increasing size of operation.

The only direct financing activity in the model is short term borrowing (BCPL). Capital borrowed in one production period must be repaid in the next period. The interest charge is 8 percent and the firm can borrow no more than 50 percent of the value of any owned assets. The borrowed capital is limited to $50,000 per period and is available for any activity that may need it.

Activities of buying land and investing in capital equipment all represent, in effect, long term borrowing activities. The capital requirements of these activities result from down payments and from demands of amortized repayment schedules over time.

Feedlot Investments

The model allows investments in four different types of cattle feeding facilities. The four types of facilities represent differing ratios of labor-capital inputs and varied terms of life. Investment levels per head refer to capital requirements at a point in time. The four activities are:

1. Build Feedlot A (BFTA)—This facility is assumed to be a medium priced investment of $60 per head. The facility is financed over a 10-year period and is assumed to be nonexistent at the end of 10 years. This facility is assumed to have a minimum investment in automated feeding equipment. It has no more than fenceline bunks and unloading wagons.

One-third of the entire cost is assumed paid as a down payment and the remainder is amortized over the 10-year period. The interest rate is assumed to be 8 percent. The objective function value in this case represents depreciation, interest on the mortgage, and a fixed charge for annual repairs, taxes, and insurance (5 percent of the new cost of the facility). The total cost is $5,480 per 100 head.

2. **Build Feedlot B (BFTB)**—This and the following two cattle investment activities employ only feeder calf-fat steer activities. This feeding facility is assumed to be a medium priced investment of $40 per head financed over a 10-year period. The system contains adequate shelters and feed storage facilities. There is little or no automated equipment.

Financing the construction of Feedlot B is identical to that for Feedlot A. The total cost is depreciation, interest, taxes, insurance and repairs. The total cost amounts to $3,490 per 100 head.

3. **Build Feedlot C (BFTC)**—This activity is assumed to be a low priced investment bordering on the temporary. The facility is nothing more than an open shed, fences, and moveable bunks. The total investment is $20 per head and has a useful life of five years.

The entire facility is paid for in the first year; thus there is no amortized schedule. The objective function value is the depreciation, taxes, repairs and insurance or $1,250 per 100 head.

4. **Build Feedlot D (BFTD)**—This facility is assumed to be an automated auger feeding system. The facility assumes investment expense of $100 per head and includes a system of storing and feeding silage as well as the automated feed augers. The system has a depreciable life of 20 years.

The total cost of depreciation, interest and fixed costs amounts to a functional value of $14,152 per 100 head.

Feeding Activities

The activities of buying calves (BCLV), growing them to feeders (GCFS), selling feeders (SFDS), feeding feeders (FFDS), and selling fat cattle (SFTC) all utilize Feedlot A. Only the two activities of selling feeders and selling fat cattle represent positive additions to the objective function.

Three yearling steer activities in the matrix are associated with a feedlot construction activity. Each activity combines the entire range of buying two yearlings, feeding them, and selling the fat cattle.

It is assumed that the yearlings are fed six months thus allowing two animals to be handled each production period. The income from only one of the two animals is made available to the capital row in that year. The income from the sale of the second animal is received in the succeeding period. This procedure prevents the matrix from using capital for an entire period when in reality it is available only at the very end of the production period.

The first yearling activity (BFSY), utilizes Feedlot B. The value of the objective function represents the total revenue from the sale of the two animals minus the cost of the two yearlings and the variable costs for feeding. Thus, the net return for this yearling activity is $192.

The next yearling activity (BFSC) utilizes Feedlot C. This activity differs from the previous activity (BFSY) by using more labor. Using Feedlot C, with its high labor requirement, represents a substitution of labor for capital, compared to Feedlot B. The net return for this activity is $192.

The third yearling activity (BFSD) utilizes Feedlot D. Feedlot D, because of automation, uses significantly less labor than the other feeding activities. The variable cost is higher than the other feeding activities thus reducing the profitability to the objective function to $182.

Swine Investment and Feeding

Two investment activities involving construction of swine facilities provide additional investment choices for the model.

1. **Build Conventional Farrowing-Finishing House (BFHS)**—This system consists of a conventional set of facilities with open-type sheds, lots and covered farrowing facilities. Total investment is $267 per sow financed over a 10-year period. The system requires a relatively high amount of labor. The objective function value is computed similar to the objective function values for the feedlot construction activities. The functional values represent the sum of depreciation, interest on the mortgage, and the fixed costs of insurance, taxes, and repairs (5 percent of the new cost) and is $4,837.58 per 10 sows.

2. **Build Confinement Farrowing House (BFHA)**—This is an environmentally controlled system. It is equipped with a lagoon, controlled farrowing facilities, and a confined feeding system with automated equipment. The total investment is $448 per sow, financed over a 10-year period (4). The total cost including depreciation and interest amounts to $8,442.58 per 10 sows.

The next two activities in the matrix (FSWS) and (FSWA) utilize the farrowing-feeding facility construction activities (BFHS) and (NFHA) respectively. For each sow, two litters of hogs are produced per year (15.5 hogs) in these activities.

Capital Activities

Paying living expenses (PLEX) removes one dollar from the capital row for each dollar in the living expense row (LEX). Paying living expenses is a slight misnomer because part of this withdrawal is fixed costs associated with expanding land base.

Paying taxes (PTAX) removes one dollar from the capital row in period t + 1 for every dollar in the tax row in period t. An equality constraint on the tax row forces this activity to take place. The functional value is zero.

Transferring capital (TCPL) and transferring additions to net worth (TNTW) both have zero functional coefficients. Any excess capital not used for taxes, living and fixed expenses, or investment is transferred if it can be used in the next production period. The same reasoning holds for the transfer net worth activity. Additions to net worth are transferred if they need to be used in succeeding periods. Any net worth transferred becomes available as security for the borrowing activity.

The activities of storing corn (STCN) and selling corn (SCRN) have objective function coefficients of zero and the price of corn ($1.10 per bushel), respectively. The same interpretation exists for storing alfalfa (STAF) and selling alfalfa (SALF). Selling soybeans (SSYB) has a functional value of its price, $2.57.

Row and Column Abbreviations

The following codes were used for the row and column name designations. Rows and activities described refer to year 1.

Row Names

OBJ11..........Objective function
LND11.........Cropland
PAS11..........Pasture
LBR11..........Labor
CPL11..........Capital
SCY11..........Security
TAX11.........Taxes
SYB11..........Soybeans
CRN11.........Corn
CNF11..........Corn for feeding
ALF11..........Alfalfa
AEF11..........Alfalfa for feeding or sale
SIL11..........Silage
CLV11..........Calves
FDR11..........Feeder calves
FCA11..........Fat cattle in Feedlot A
FTA11..........Capacity of Feedlot A
FTB11..........Capacity of Feedlot B
FTC11..........Capacity of Feedlot C
FTD11.........Capacity of Feedlot D
FHS11..........Capacity of Conventional Farrowing House
FHA11..........Capacity of Confinement Farrowing House
LEX11..........Living and Fixed Expenses
NTR11.........Net Returns
NTW11.......Additions to Net Worth

Column Names

RHSA99 ...... Right Hand Side
GCRN11 ...... Grow Corn
GCNS11 ...... Grow Corn for Silage
GSYB11 ...... Grow Soybeans
GALF11 ...... Grow Alfalfa
PAST11 ...... Grow Pasture
HLBR11 ...... Hire Labor
BLNM11 ...... Buy Land for Mortgage
BFTA11 ...... Build Feedlot A
BFTB11 ...... Build Feedlot B
BFTC11 ...... Build Feedlot C
BFTD11 ...... Build Feedlot D
BCPL11 ...... Borrow Capital
BCLV11 ...... Buy Calves
GCFS11 ...... Grow Calves to Feeders
SFDS11 ...... Sell Feeders
FFDS11 ...... Feed Feeders
SFTC11 ...... Sell Fat Cattle From Feedlot A
BFSY11 ...... Buy, Feed, and Sell Yearlings in Feedlot B
BFSC11 ...... Buy, Feed, and Sell Yearlings in Feedlot C
BFSD11 ...... Buy, Feed, and Sell Yearlings in Feedlot D
BFHS11 ...... Build Conventional Farrowing-Feeding Swine Facility
BFHA11 ...... Build Confinement Farrowing-Feeding Swine Facility
FSWS11 ...... Farrow, Feed, and Sell Swine in Farrowing House
FSWA11 ...... Farrow, Feed, and Sell Swine in Farrowing House A
STCN11 ...... Store Corn
SCRN11 ...... Sell Corn
STAF11 ...... Store Alfalfa
SALF11 ...... Sell Alfalfa
SSYB11 ...... Sell Soybeans
PLEX11 ...... Pay Living and Fixed Expenses
PTAX11 ...... Pay Taxes
TCPL11 ...... Transfer Capital
TNTW11 ...... Transfer Net Worth

To show the interdependence of the model, the first two years of Model I are presented in Table 1.

Rows

The rows section of the polyperiod matrix represents the resources available to the firm during each production period. The a_{ij}'s in any one row represent a series of additions to the right hand side (a_{ij}'s with negative signs) or subtractions from the right hand side (a_{ij}'s

Table 1. Coefficients for the first two years of the matrix for Model I.

Row names	Row types	Right hand side	Columns									
		RHSA99	GCRN11	GCNS11	GSYB11	GALF11	PAST11	HLBR11	BLNM11	BFTA11	BFTB11	BFTC11
OBJ11	N		–28.29	–34.21	–20.18	–30.00	–4.70	–2.00	–162.90	–4503.37	–2946.75	–1223.26
LND11	L	320.00	1.00	1.00	1.00	1.00	1.00		–1.00	.34	.34	.34
PAS11	L						–1.00					
LBR11	L	2080.00	4.92	6.25	4.51	5.60	2.00	–1.00				
CPL11	L	10000.00	28.29	34.21	20.18	30.00	4.70	2.00	127.36	1310.00	1180.00	1050.00
SCY11	L	96000.00							200.00	–3000.00	–2000.00	–1000.00
TAX11	E	–1000.00	5.66	6.84	4.04	6.00	.94	.40	6.20	262.00	236.00	210.00
SYB11	L				–30.00							
CRN11	L		–85.00									
CNF11	L											
ALF11	L					–4.00						
AFF11	L											
SIL11	L			–10.00								
CLV11	L											
FDR11	L											
FCA11	L											
FTA11	L									–100.00		
FTB11	L										–100.00	
FTC11	L											–100.00
FTD11	L											
FHS11	L											
FHA11	L											
LEX11	E	15000.00							–11.00			
NTR11	N		28.29	34.21	20.18	30.00	4.70	2.00	20.00	1310.00	1180.00	1050.00
NTW11	L											
LND12	L	320.00							–1.00	.34	.34	.34
PAS12	L											
LBR12	L	2080.00										
CPL12	L								23.36	521.18	285.59	50.00
SCY12	L	96000.00							192.64	–2000.00	–1000.00	–800.00
TAX12	E	–1000.00							5.28	104.24	57.12	10.00

Table 1—continued.

Row names	Row types	Right hand side	Columns									
		RHSA99	GCRN11	GCNS11	GSYB11	GALF11	PAST11	HLBR11	BLNM11	BFTA11	BFTB11	BFTC11
SYB12	L											
CRN12	L											
CNF12	L											
ALF12	L											
AFF12	L											
SIL12	L											
CLV12	L											
FDR12	L											
FCA12	L											
FTA12	L									–100.00		
FTB12	L										–100.00	
FTC12	L											–100.00
FTD12	L											
FHS12	L											
FHA12	L											
LEX12	E	15000.00							–11.00			
NTR12	N								15.41	521.18	285.59	50.00
NTW12	L								–7.95			

Table 1. Coefficients for the first two years of the matrix for Model I. (continued).

Row names	Columns											
	BFTD11	BCPL11	BCLV11	GCFS11	SFDS11	FFDS11	SFTC11	BFSY11	BFSC11	BFSD11	BFHS11	BFHA11
OBJ11	–9239.71	–8.00	–116.32	–5.00	175.20	–25.00	264.21	138.70	138.70	128.70	–3999.89	–6819.66
LND11	.34										.10	.10
PAS11				1.50								
LBR11				2.00				4.00	7.60	2.10		
CPL11	1570.00	–100.00	116.32	2.50			–280.06	141.36	141.36	151.36	1267.95	1503.44
SCY11	–5000.00	200.00	–116.32	–185.71				185.71	–185.71	185.71	–2676.54	–4488.00
TAX11	314.00		23.26	.50				–56.01	27.74	25.74	253.59	300.69
SYYB11												
CRN11												
CNF11				6.00				92.00	92.00	92.00		
ALF11												
AFF11								1.00	1.00			
SIL11										3.00		
CLV11			–1.00	1.00								
FDR11												
FCA11												
FTA11												
FTB11								2.00				
FTC11									2.00			
FTD11										2.00		
FHS11											–10.00	
FHA11												–10.00
LEX11												
NTR11												
NTW11			116.32	2.50			–280.06	–138.70	–138.70	–128.70	1267.95	1503.44
LND12												
PAS12												
LBR12				1.00		4.00						
CPL12	773.52	108.00		2.50	–185.71	25.00		–280.06	–280.06	–280.06	444.98	871.74
SCY12	–4000.00	–200.00		–156.00	185.71						–1676.54	–3488.00
TAX12	154.70	1.60		.50	–37.14	5.00	–56.00				89.00	174.35
SYB12												

Table 1—continued.

Row names	Columns										
	BFTD11	BCPL11	BCLV11	GCFS11	SFDS11	FFDS11	SFTC11	BFSY11	BFSC11	BFSD11	BFHS11	BFHA11
CRN12												
CNF12				6.00		48.00						
ALF12												
AFF12				.10		.40						
SIL12				.20		.80						
CLV12												
FDR12				-1.00	1.00	1.00						
FCA12						-1.00	1.00					
FTA12						1.00						
FTB12												
FTC12												
FTD12												
FHS12											-10.00	
FHA12												-10.00
LEX12												
NTR12	773.52	8.00		2.50	-185.71	25.00	-280.00				444.98	871.74
NTW12							-4.00					

Table 1. Coefficients for the first two years of the matrix for Model I. (continued).

Row names	Columns									
	FSWS11	FSWA11	STCN11	SCRN11	STAF11	SALF11	SSYB11	PLEX11	PTAX11	TCPL11	TNTW11
OBJ11	436.92	436.92		1.10		20.00	2.57				
LND11											
PAS11											
LBR11											
CPL11								1.00		1.00	
SCYY11											
TAX11									1.00		
SYB11							1.00				
CRN11											
CNF11											
ALF11					1.00						
AFF11					−1.00	1.00					
SIL11											
CLV11											
FDR11											
FCA11											
FTA11											
FTB11											
FTC11											
FTD11											
FHS11											
FHA11								1.00			
LEX11											
NTR11	−436.92	−436.92								1.00	
NTW11											
LND12											
PAS12											
LBR12											
CPL12											
SCY12	−313.72	−313.72		−1.10		−20.00	−2.57		1.00	−1.00	
TAX12											−1.00
SYB12				−.22		−4.00	−.51				

Table 1—continued.

Row names	Columns										
	FSWS11	FSWA11	STCN11	SCRN11	STAF11	SALF11	SSYB11	PLEX11	PTAX11	TCPL11	TNTW11
CRN12											
CNF12											
ALF12											
AFF12											
SIL12											
CLV12											
FDR12											
FCA12											
FTA12											
FTB12											
FTC12											
FTD12											
FHS12											
FHA12											
LEX12											
NTR12	–322.57			–1.10		–20.00	–2.57				
NTW12				.55		–8.50	–1.38				–1.00

with positive signs). All rows are specified as to their type, i.e., L (less than or equal), G (greater than or equal), E (equality restraints), or N (non-constraint rows) (Table 1). The non-constraint rows may serve as simply accounting rows.

The set of constraint rows in this study generally follows standard techniques and interpretations. The security row (SCY) represents the amount of collateral that exists for the borrowing activity. The initial collateral is the value of the owned land, $96,000. Other activities such as the building feedlot activities contribute to the security resource in that they become available as collateral for borrowing.

The tax row (TAX) represents an accounting of tax liabilities and credits that are eventually withdrawn from the capital stream by the activity that pays taxes (PATX). The tax rate is assumed to be 20 percent. Activities that possess only costs and no returns (negative) are given a tax credit and activities with positive contributions are charged a tax liability at the 20 percent rate.

Price Assumptions

Models I–V employed constant product prices over the 20-year programming period (Table 2). Model V involved generally lower livestock prices than Models I–IV but crop prices were the same for all models. Models I–IV differed from each other only in resource restrictions.

Models VI and VII employed cyclical prices for livestock. A 10-year (1959–68) cycle was used for cattle prices with a 5-year cycle for hogs (Table 3). The price cycles were repeated for the 20-year programming period. Averages of the cyclical cattle and hog prices equal the constant prices of Model V. Crop prices remained the same for all models.

Table 2. Prices used in the constant price models.

	Unit	Model I-IV[a]	Model V
Calves	cwt	29.00	29.08[b]
Feeder steers	cwt	28.00	26.53[c]
Fat steers	cwt	26.00	25.46[c]
Market hogs	cwt	19.82	19.27[c]
Corn	bushel	1.10	1.10[a]
Alfalfa	ton	20.00	20.00[a]
Soybeans	bushel	2.57	2.57[a]

[a] Allen C. Wellman, 1970. Prices For Farm Planning in Nebraska, 1969, E.C. 70-840, University of Nebraska Cooperative Extension Service.

[b] U.S. Department of Agriculture, *Livestock Market News*, Washington, D.C., 1959–1968, Feeder Calf Prices, Omaha Terminal Market.

[c] U.S. Department of Agriculture, Livestock and Meat Statistics, Statistical Bulletin, No. 333, Supplement, Table 166, Washington, D.C. Feeder steers are average of *1959–1968 prices; hogs* 1964–68 price average.

Table 3. Livestock prices used in cyclical price models VI and VII.

Year	Choice feeder calves[a]	Choice feeder steers[b]	Choice slaughter steers[b]	No. 1 and 2 slaughter hogs[c]
1959	34.86	30.67	27.51	
1960	28.58	26.61	25.76	
1961	28.46	23.98	24.27	
1962	30.07	27.54	27.14	
1963	26.99	25.97	23.37	
1964	25.18	22.42	22.42	15.24
1965	26.27	24.35	25.32	20.99
1966	30.15	28.13	25.65	23.25
1967	30.08	27.46	25.22	19.17
1968	30.19	28.13	27.96	17.70

[a] Average Annual Feeder Calf Prices Omaha Terminal Market, U.S. Department of Agriculture, *Livestock Market News*, Washington, D.C.

[b] U.S. Department of Agriculture, *Livestock and Meat Statistics*, Statistical Bulletin No. 333, Supplement U.S. Government Printing Office, Washington, D.C., Table 166.

[c] U.S. Department of Agriculture, *Livestock and Meat Statistics*, Statistical Bulletin No. 333, Supplement U.S. Government Printing, Office, Washington, D.C., Table 168.

Models VI and VII differ from each other only in the relation of the hog and cattle price cycle. Model VI used cyclical prices of Table 3 commencing with 1959 cattle prices and 1964 hog prices. This pattern represented a situation with initially high cattle and low hog prices. Model VII employed 1963 as a starting point for cattle prices and 1968 for hog prices. This price situation represented low initial prices for both hogs and cattle.

ANALYSIS OF RESOURCE LEVELS

In this section results of four constant-price models are discussed. Under the constant-price assumptions, differences in resource restrictions can be analyzed with respect to their influence on investments and farm enterprise alternatives. Four solutions were determined using the basic constant prices of Table 2 by changing the right hand side coefficients. The different right hand sides represent differing combinations of land, labor and capital. The four models are:

I. The operator starts with 320 acres of land (100% equity), beginning capital of $10,000 and a limit of hiring labor of 4,000 hours annually.

II. The operator starts with 320 acres of land (100% equity), beginning capital of zero and hiring labor limited to 4,000 hours annually. This model would represent an operator with limited capital, but is willing to hire labor from the capital stream.

III. The operator starts with 320 acres of land (100% equity), beginning capital of $10,000 and the limit to hire labor at zero. This situation represents the farm operator who does not wish to utilize anything but his own labor in his farming business.

IV. Because the probability of a farmer beginning with full ownership of 320 acres is low, Model IV was designed assuming the farmer owns and operates only 80 acres at 100 percent equity. With full ownership, however, his total equity available as collateral is $24,000. Thus his borrowing capacity is restricted in the early years of the planning horizon compared to the other models. Labor and capital restrictions are the same as Model I.

All models in this study had borrowing short term capital restricted to $50,000 annually or 50 percent of equity, whichever is less.

Model I

Resource use from the solution of Model I is shown in Table 4. Capital was borrowed at the limit of $50,000 for the first seven years. During these years the capital was needed for down payments and mortgage payments on land and livestock investments. No capital was borrowed after year 8. The land base increased from 320 acres to 759 acres in the first eight years of the period through land purchases.

Investments in livestock facilities for Model I are summarized in Table 5. Net returns to the farm unit were maximized by an organization that invests in a medium-priced cattle feeding system (Feedlot B) and the conventional type of swine-farrow-finishing system. Investments listed in Table 5 represent new additions to capacity in each year. Investments in cattle feeding facilities refer to levels of capacity at a point in time. Two cattle per year can be fed with one unit of capacity of Feedlot B. The cumulative effects of cattle feeding investments are represented in Table 5 through the total number of animals fed annually.

Table 4. Summary of resource use: Model I.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
1	50,000.00	2,999.64	52.41	372.41
2	50,000.00	3,472.33	59.01	431.42
3	50,000.00	4,000.00	65.88	497.30
4	50,000.00	4,000.00	58.24	555.54
5	50,000.00	4,000.00	62.23	617.77
6	50,000.00	4,000.00	66.35	684.12
7	50,000.00	4,000.00	70.73	754.85
8	22,766.00	4,000.00	4.25	759.10
9	0.00	4,000.00	0.00	759.10
10	0.00	4,000.00	0.00	759.10
11	0.00	4,000.00	0.00	759.10
12	0.00	4,000.00	0.00	759.10
13	0.00	4,000.00	0.00	759.10
14	0.00	4,000.00	0.00	759.10
15	0.00	4,000.00	0.00	759.10
16	0.00	4,000.00	0.00	759.10
17	0.00	4,000.00	0.00	759.10
18	0.00	4,000.00	0.00	759.10
19	0.00	4,000.00	0.00	759.10
20	0.00	4,000.00	0.00	759.10

Table 5. Summary of livestock investments and crop and livestock activity levels: Model I.

Year	Livestock investments			Livestock fed			Crops	
	Cattle feedlot B	Conventional farrowing	Confinement farrowing	Cattle feedlot B	Hogs conventional farrowing	Hogs confinement farrowing	Corn	Alfalfa
	(head)	(sows)	(sows)	(head)	(head)	(head)	(acres)	(acres)
1	150.50	77.60	0.30	301.06	1,202.80	5.58	332.97	37.63
2	44.00	0.00	0.00	389.20	1,202.80	5.58	380.68	48.65
3	49.00	0.00	0.00	487.60	1,202.80	5.58	433.93	60.95
4	71.50	0.00	0.00	630.82	935.11	5.58	473.79	78.85
5	76.50	0.00	0.00	783.88	649.29	5.58	516.37	97.98
6	81.50	0.00	0.00	947.02	344.41	5.58	561.78	118.37
7	86.50	0.00	0.00	1,120.96	19.53	5.58	610.18	140.12
8	5.00	0.00	0.00	1,131.42	0.00	5.58	613.09	141.42
9	0.00	0.00	0.00	1,131.42	0.00	5.58	613.09	141.42
10	0.00	0.00	0.00	1,131.42	0.00	5.58	613.09	141.42
11	151.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
12	44.00	0.00	0.00	1,133.78	0.00	0.00	613.56	141.42
13	49.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
14	71.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
15	76.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
16	81.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
17	86.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
18	5.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
19	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42
20	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.42

The solution to Model I was optimized when investments were made in the medium-priced cattle feeding facility (BFTB) exclusively. The investment in year 1 resulted in capacity for 301 head of yearling cattle to be fed and marketed. Investments continued throughout the period until capacity for 1133 head was reached and maintained at this level from years 11 through 20. A small fraction of cropland was required for cattle and hog facilities.

The only swine facility investment of significance was in conventional facilities in year 1. This large investment, 77.6 units of capacity was required to provide quick capital turnover to generate capital to make down payments on the land purchased, to make mortgage payments and to provide capital for investment in cattle-feeding enterprises. The number of hogs fed annually decreased steadily after the third year and after year 7 the swine facility was completely abandoned in favor of expanded cattle feeding capacity. The investment in confinement swine farrowing is small enough to be practically ignored.

Corn was the principal crop grown. Enough alfalfa was grown to support the cattle feeding activity. No silage was grown because the cattle feeding activity to utilize it was not brought into the optimal solution.

Model II

Resource restrictions for Model II were identical to Model I except the amount of capital available in year 1 was reduced to zero dollars. Results of this solution are similar to the pattern for Model I and are shown in Tables 6 and 7. The lack of starting capital restricted the purchase of land early in the planning horizon compared to Model I.

Investment in the swine farrowing-feeding facility was greater in Model II than Model I in the first year. As in Model I, capital was borrowed to the limit, $50,000 for the first seven years. No capital was borrowed from years 10 through 20. Capital was borrowed at the limit to finance land purchases in the first half of the planning period.

Total acres of land purchased were identical to Model I. However, the distribution of purchases over the entire period was different. The lack of starting capital forced the operation to change its investment strategy away from a heavy commitment to land in the first year to larger purchases later in the period. Only 24.54 acres of land were purchased in the first year. No land was purchased after year 8. The limit on hiring labor was reached in the third year. Expanding livestock and crop enterprises used all the labor that could be hired.

The timing of investments in livestock facilities is displayed in Table 7. The cattle feedlot choice was the medium priced investment, Feedlot B. The pattern of investments was similar to the pattern for

Table 6. Summary of resource use: Model II.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
	(Dollars)	(Hours)	(Acres)	(Acres)
1	50,000.00	3,051.56	24.54	344.54
2	50,000.00	3,500.39	56.04	400.58
3	50,000.00	4,000.00	62.38	462.96
4	50,000.00	4,000.00	55.18	518.14
5	50,000.00	4,000.00	58.99	577.13
6	50,000.00	4,000.00	62.93	640.06
7	50,000.00	4,000.00	67.14	707.20
8	42,460.01	4,000.00	51.92	759.12
9	13,179.00	4,000.00	0.00	759.12
10	0.00	4,000.00	0.00	759.12
11	0.00	4,000.00	0.00	759.12
12	0.00	4,000.00	0.00	759.12
13	0.00	4,000.00	0.00	759.12
14	0.00	4,000.00	0.00	759.12
15	0.00	4,000.00	0.00	759.12
16	0.00	4,000.00	0.00	759.12
17	0.00	4,000.00	0.00	759.12
18	0.00	4,000.00	0.00	759.12
19	0.00	4,000.00	0.00	759.12
20	0.00	4,000.00	0.00	759.12

Model I and the total capacity reached the same level, 1133 head annually. Reinvestments in feedlot capacity were made after earlier-built feedlots were depreciated out. The number of yearlings fed increased to a peak of 1133 in year 11 and was maintained through year 20.

The investment in swine facilities was about 10 units greater in Model II over Model I. The explanation lies in the fact that because starting capital was restricted in Model II, the optimum strategy found was to invest more heavily in swine in the first year as a means of generating sufficient capital for expansion. These results at the prices assumed support the common hypothesis that swine allow for quick capital turnover. However, cattle provide for greater long run profitability.

The swine facility was used to capacity for the first three years. Use of the swine facility dropped rapidly so that the facility, which had three full years of useable life remaining, was abandoned in year 8 and remained unused until its assumed lifespan of 10 years was reached. The combination of capital availability, labor use differentials and profitability between cattle and hogs caused the shift from hog raising to feeding cattle.

Corn and alfalfa dominated cropping activities. Both corn and alfalfa were used in the cattle feeding activities. The mix of corn and alfalfa was identical for the last 10 years of Models I and II.

In summary, compared to Model I, the investment strategy resulting from Model II was to restrict land purchase during the first years

Table 7. Summary of livestock investments and crop and livestock activity: Model II.

Year	Livestock investments			Livestock fed			Crops	
	Cattle feedlot B	Conventional farrowing	Confinement farrowing	Cattle feedlot B	Hogs conventional farrowing	Hogs confinement farrowing	Corn	Alfalfa
	(head)	(sows)	(sows)	(head)	(head)	(head)	(acres)	(acres)
1	112.50	87.70	0.40	225.94	1,360.59	6.20	314.64	28.24
2	41.50	0.00	0.00	309.64	1,360.59	6.20	359.94	38.70
3	46.50	0.00	0.00	402.80	1,360.59	6.20	410.36	50.35
4	67.50	0.00	0.00	538.50	1,107.01	6.20	448.12	67.31
5	72.50	0.00	0.00	683.58	836.07	6.20	488.49	85.44
6	77.00	0.00	0.00	838.34	546.84	6.20	531.56	104.79
7	82.50	0.00	0.00	1,003.44	238.39	6.20	577.50	125.43
8	63.50	0.00	0.00	1,131.12	0.00	6.20	613.03	141.39
9	0.00	0.00	0.00	1,131.12	0.00	6.20	613.03	141.39
10	0.00	0.00	0.00	1,131.12	0.00	6.20	613.03	141.39
11	114.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
12	41.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
13	46.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
14	67.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
15	72.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
16	77.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
17	82.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
18	63.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
19	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
20	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72

and invest more heavily in activities that yielded a high capital turnover rate.

Model III

Model III represents a firm restricted in the amount of labor that can be hired. The assumption was that the operator was not capable of managing or did not desire to manage more than his own labor, 2,080 hours per year. The operator started with 320 acres of land and $10,000 of capital in year 1.

Capital was borrowed in only the first four years (Table 8). This was needed for the financing of feedlot construction made the first year. No land was purchased. Furthermore, because labor hiring was restricted, cropland went unused from years 5 through 15. In those years heavier activity in cattle feeding restricted crop production. Livestock investments and annual crop and livestock activity levels for Model III are shown in Table 8. No swine investments occur in the optimal solution of Model III. Swine activities played an important role in providing capital to the operation in the two previous solutions. However, because swine activities are labor intensive and in this model labor is restricted, the solution is optimized when expansion moves toward feeding cattle instead of feeding hogs.

Expansion in cattle feeding again occurred in the medium priced investment. In spite of the fact that labor was limited, an investment in the highly mechanized, and therefore labor saving, feeding system was not made. This can be explained because the cost of the mech-

Table 8. Summary of resource use: Model III.

Year	Borrowed capital	Land purchased	Unused cropland
	(Dollars)	(Acres)	(Acres)
1	31,633.01	0.00	0.00
2	22,160.00	0.00	0.00
3	14,768.00	0.00	0.00
4	6,924.00	0.00	0.00
5	0.00	0.00	10.00
6	0.00	0.00	59.86
7	0.00	0.00	59.86
8	0.00	0.00	59.86
9	0.00	0.00	59.86
10	0.00	0.00	59.86
11	0.00	0.00	59.86
12	0.00	0.00	59.86
13	0.00	0.00	59.86
14	0.00	0.00	59.86
15	0.00	0.00	49.86
16	0.00	0.00	0.00
17	0.00	0.00	0.00
18	0.00	0.00	0.00
19	0.00	0.00	0.00
20	0.00	0.00	0.00

Table 9. Summary of livestock investments and crop and livestock activity: Model III.

Year	Livestock investments: Cattle feedlot B	Livestock fed: Cattle feedlot B	Crops: Corn	Crops: Alfalfa
	(head)	(head)	(acres)	(acres)
1	122.00	244.44	288.61	30.55
2	0.00	244.44	288.61	30.55
3	0.00	244.44	288.61	30.55
4	0.00	244.44	288.61	30.55
5	12.00	268.48	275.42	33.56
6	59.50	387.86	209.90	48.48
7	0.00	387.86	209.90	48.48
8	0.00	387.86	209.90	48.48
9	0.00	387.86	209.90	48.48
10	0.00	387.86	209.90	48.48
11	122.00	387.86	209.90	48.48
12	0.00	387.86	209.90	48.48
13	0.00	387.86	209.90	48.48
14	0.00	387.86	209.90	48.48
15	0.00	363.82	223.09	45.47
16	0.00	244.44	288.61	30.55
17	0.00	244.44	288.61	30.55
18	0.00	244.44	288.61	30.55
19	0.00	244.44	288.61	30.55
20	0.00	244.44	288.61	30.55

anized system was greater than the value of the labor that would be released. In year 1 investments were made to feed 244 head of cattle annually. In years 5 and 6 additional facilities were constructed and in year 11 an investment was made to replace the facility built in year 1. The number of cattle fed peaked at 387 head from years 6 through 14 (Table 9). The number of cattle fed dropped to 244 in the last five years of the planning period.

Corn and alfalfa dominated the cropping activities. Just enough alfalfa was grown to supply the cattle feeding requirements. No corn was raised for silage because no feeding systems required silage.

Model IV

The fourth situation in the series of constant price models starts the period with the operator owning only 80 acres of land rather than 320 acres. The 80 acres of land reduces the security available for collateral from $96,000 to $24,000. This model assumes initially $10,000 of capital remaining from the previous year's activity and the hiring labor limit is set at 4,000 hours annually.

The optimal solution to Model IV relied heavily on borrowing capital to expand its enterprises. In 10 of the 20 years the firm bor-

Table 10. Summary of resource use: Model IV.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
	(Dollars)	(Hours)	(Acres)	(Acres)
1	20,357.00	267.94	68.13	148.13
2	42,537.01	2,411.70	105.57	253.70
3	50,000.00	3,651.02	61.03	314.73
4	50,000.00	3,888.06	29.59	344.32
5	50,000.00	4,000.00	29.14	373.46
6	50,000.00	4,000.00	28.93	402.39
7	50,000.00	4,000.00	31.29	433.68
8	50,000.00	4,000.00	33.80	467.48
9	36,026.00	4,000.00	0.00	467.48
10	20,863.00	4,000.00	0.00	467.48
11	50,000.00	4,000.00	106.02	573.50
12	50,000.00	3,913.01	42.94	616.44
13	50,000.00	3,475.97	39.13	655.57
14	50,000.00	4,000.00	65.42	720.99
15	42,783.01	4,000.00	38.20	759.19
16	18,098.00	4,000.00	0.00	759.19
17	18,098.00	4,000.00	0.00	759.19
18	0.00	4,000.00	0.00	759.19
19	0.00	4,000.00	0.00	759.19
20	0.00	4,000.00	0.00	759.19

rowed capital at the $50,000 limit (Table 10). In seven other years less than the limit was borrowed and in the last three years no capital was borrowed. Enough capital was generated in these three years to meet all capital withdrawals. The capital borrowing was necessary to support a nearly continuous program of investments in cattle feedlots, swine farrow-feeding facilities and land.

The final amount of land operated in the 20th year of the planning period was identical to the amounts in Models I and II except for rounding differences. In this model because the starting size was only 80 acres, an additional 240 acres had to be purchased. The fact that three of these situations all resulted in the same size unit is not too surprising considering that further expansion was limited by the ability to hire labor.

Labor was hired to the limit in all years after year 5 except years 12 and 13 when combined cattle and hog production was lower than other years.

Expansion in livestock activities is expressed in Table 11. No cattle feeding facilities were constructed in the first three years. Swine farrowing-feeding investments dominate the first three periods. In contrast to the previous models, there was a significant investment in the confinement farrowing-feeding system. In the first year capacity for confinement farrowing of 67.6 sows was constructed. In the second year capacity for 48.1 sows was constructed in conventional facilities. A second major investment in the conventional facility was made in year 3. Another investment in conventional facilities was made in

Table 11. Summary of livestock investments and crop and livestock activity: Model IV.

Year	Livestock investments			Livestock fed			Crops	
	Cattle feedlot B	Conventional farrowing	Confinement farrowing	Cattle feedlot B	Hogs conventional farrowing	Hogs confinement farrowing	Corn	Alfalfa
	(head)	(sows)	(sows)	(head)	(head)	(head)	(acres)	(acres)
1	0.00	0.00	67.60	0.00	0.00	1,047.80	147.45	0.00
2	0.00	48.10	0.00	0.00	746.79	1,047.80	252.55	0.00
3	0.00	27.80	0.00	0.00	1,178.46	1,047.80	313.30	0.00
4	22.00	0.00	0.00	44.20	1,178.46	1,047.80	337.23	5.52
5	29.00	0.00	0.00	102.36	1,108.87	1,047.80	358.90	12.79
6	35.50	0.00	0.00	173.52	975.88	1,047.80	378.70	21.69
7	38.00	0.00	0.00	250.46	832.19	1,047.80	400.11	31.30
8	41.50	0.00	0.00	333.58	676.88	1,047.80	423.24	41.69
9	0.00	0.00	0.00	333.58	676.88	1,047.80	423.24	41.69
10	0.00	0.00	0.00	333.58	676.88	1,047.80	423.24	41.69
11	170.50	0.00	0.00	675.50	856.06	0.00	486.05	94.43
12	58.00	11.30	0.00	792.50	607.13	0.00	514.34	99.06
13	74.50	0.00	0.00	942.10	175.46	0.00	534.55	117.76
14	70.50	0.00	0.00	1,039.82	175.46	0.00	587.43	129.97
15	76.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
16	35.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
17	38.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
18	41.50	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
19	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72
20	0.00	0.00	0.00	1,133.78	0.00	0.00	613.57	141.72

year 12 partially replacing facilities built in year 2. The first investment in a cattle feeding system was in year 4. A total annual cattle feeding level in the medium priced investment was established at 1134 head annually.

The pattern of livestock investments can be explained similar to the investments in Model II. That is, swine activities provide large amounts of capital that can subsequently be used for buying land and investing in cattle feeding facilities. No hogs were fed in the last five years thus there was an unused capacity for 11 sows to be farrowed because of the relatively high labor requirements of swine.

Resource Level Summary

Figures 2 through 4 graphically summarize the enterprise organizations which lead to maximum growth for each model. The general trend of initially high levels of hog production giving way to cattle production and increased cropland is shown for Model I. In Model II where capital is restricted, greater hog production occurs early in the time period serving to generate capital. In Model II similar overall cattle and land purchase activity occurs as in Model I but is delayed for capital generation.

In Model III labor is restricted. Hogs, because of high labor use, do not enter the optimal solution. Rather, the optimal solution is one of a mix of cattle and cropland with owned cropland remaining constant. In Model IV initial land holdings were restricted to 80 acres. However, the growth pattern was basically similar to Models I and II, high early hog activity combined with increased cattle and cropland. Level of hog activity for Model IV was the highest of all four models.

Overall, the resource restriction which affected the general resource organization most was the restricted labor structure of Model III. This restriction on labor led to far less activity and growth than the other models. In addition, restricted labor led to the absence of the high labor-requiring hog activities.

EFFECTS OF PRICE LEVEL MODEL V

This section presents the solution to Model V. This model has identical initial resource levels as Model I, however product price assumptions differ. As shown in Table 2, livestock prices are generally lower in Model V compared to Model I while crop prices remain the same.

Results of the solution for Model V reflect the greater relative profitability of crop production in Model V compared to Model I. The solution basically includes a high level of hog production for capital generation purposes. No cattle feeding activities are included

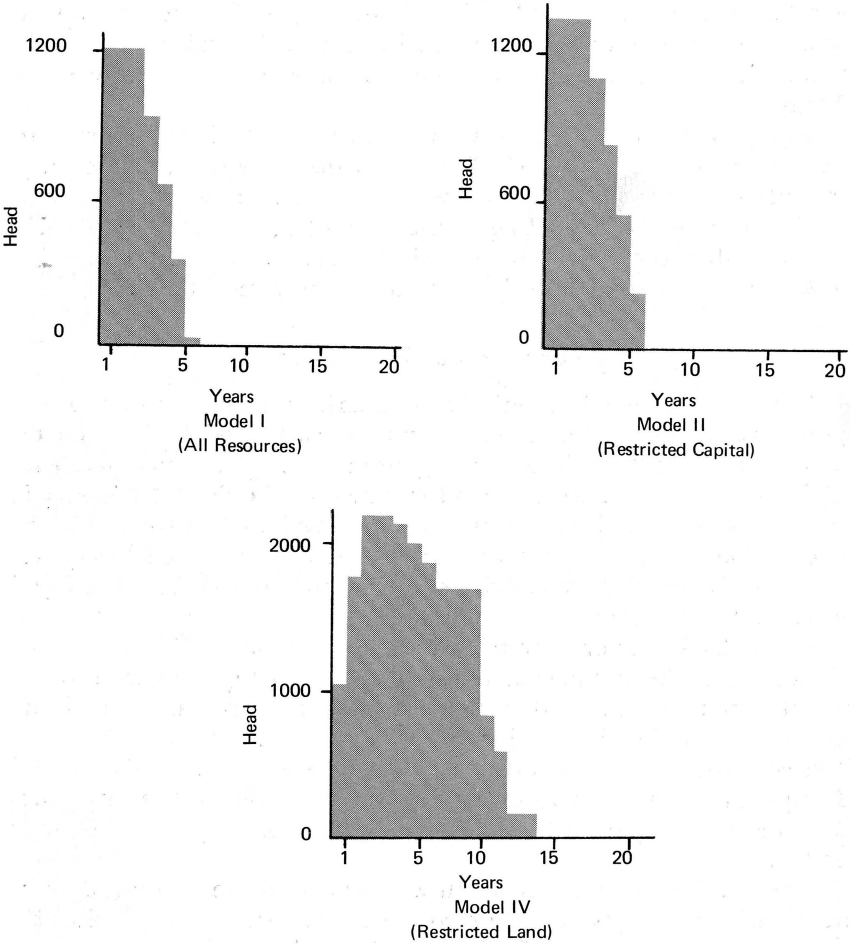

Figure 2. Total number of hogs fed annually.

but more cropland is purchased in Model V compared to Model I reflecting the higher relative crop production profitability of Model V.

Total owned cropland reaches a level of 1236 acres by year 11 (Table 12). This acreage may be compared to 759 acres in Model I. This level is reached through purchases in the first five years plus additions in years 9, 10 and 11. Hired labor reaches its maximum restriction by year 3 as was the case in Model I. Large amounts of capital are borrowed early in the period plus a moderate borrowing in year 11.

Operating and investment activities for Model V are given in Table 13. A relatively high level of hog production occurs in Model V over the first 10 years. Because hog production tends to remain at a stable level over the period of the swine investment, confinement

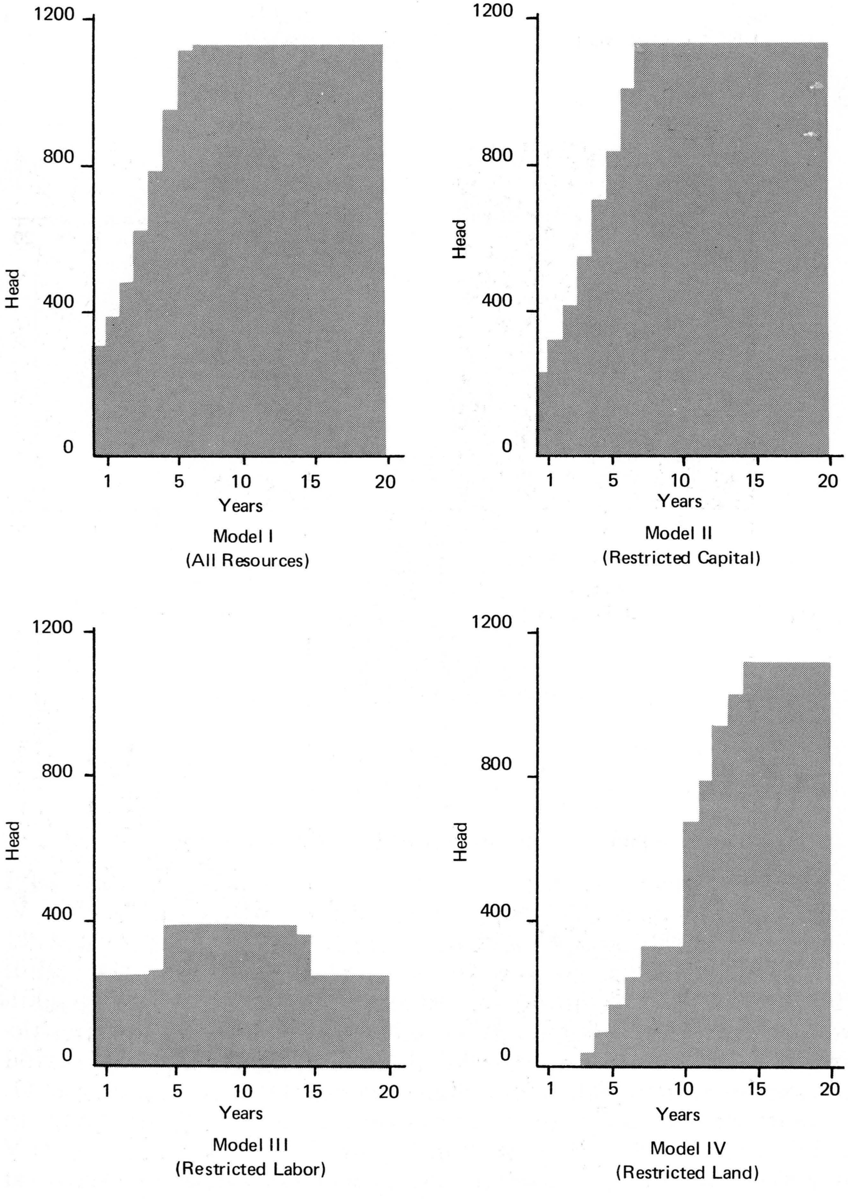

Figure 3. Total number of cattle fed in Feedlot B.

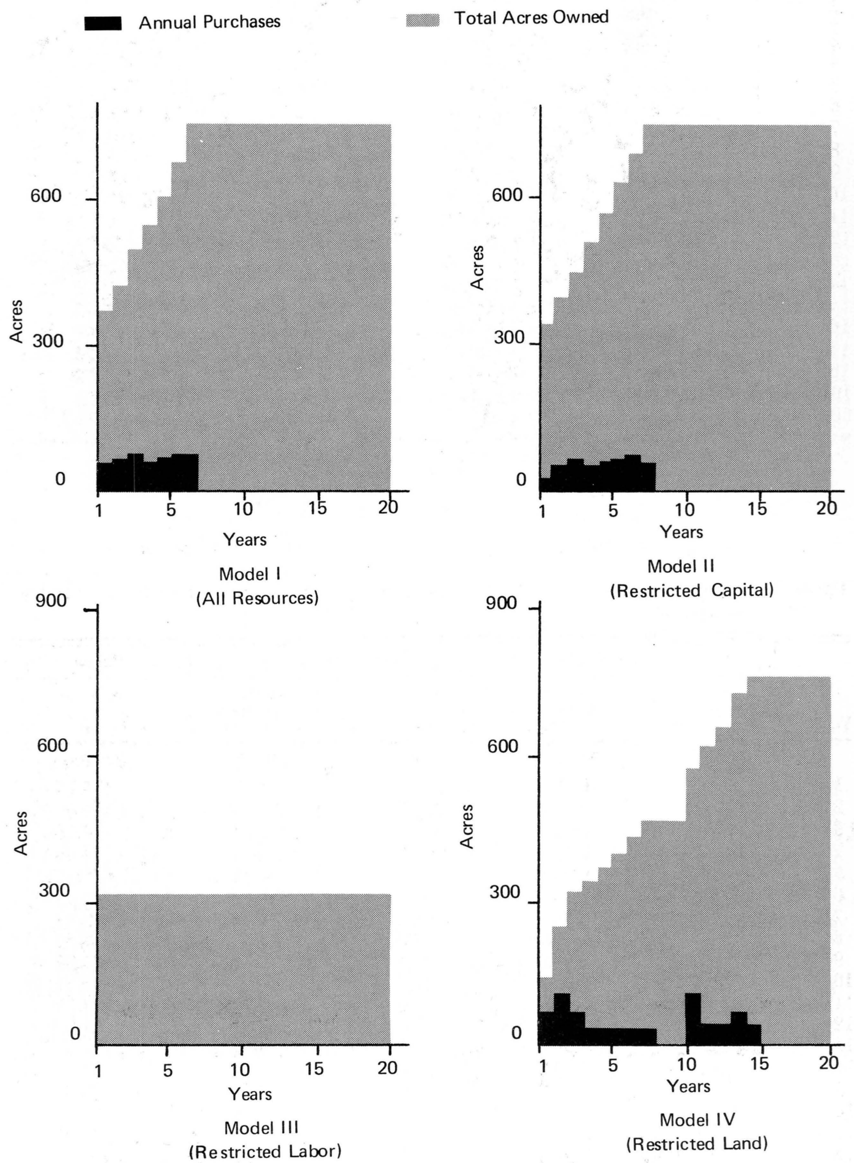

Figure 4. Annual purchases and total acres of land owned.

Table 12. Summary of resource use: Model V.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
	(Dollars)	(Hours)	(Acres)	(Acres)
1	50,000.00	3,101.51	165.22	485.22
2	50,000.00	3,578.00	96.85	582.07
3	50,000.00	4,000.00	85.77	667.84
4	50,000.00	4,000.00	88.69	756.53
5	50,000.00	4,000.00	90.69	847.22
6	33,428.72	4,000.00	0.00	847.22
7	17,700.61	4,000.00	0.00	847.22
8	828.97	4,000.00	0.00	847.22
9	0.00	4,000.00	90.14	937.36
10	0.00	4,000.00	100.33	1,037.69
11	14,159.07	4,000.00	198.10	1,235.79
12	0.00	4,000.00	0.00	1,235.79
13	0.00	4,000.00	0.00	1,235.79
14	0.00	4,000.00	0.00	1,235.79
15	0.00	4,000.00	0.00	1,235.79
16	0.00	4,000.00	0.00	1,235.79
17	0.00	4,000.00	0.00	1,235.79
18	.00	4,000.00	0.00	1,235.79
19	0.00	4,000.00	0.00	1,235.79
20	0.00	4,000.00	0.00	1,235.79

Table 13. Summary of livestock investments and crop and livestock activity: Model V.

	Livestock investments		Livestock fed		Crops
Year	Conventional farrowing	Confinement farrowing	Hogs conventional farrowing	Hogs confinement farrowing	Corn
	(Sows)	(Sows)	(Head)	(Head)	(Acres)
1	26.10	79.80	405.17	1,237.98	484.16
2	0.00	0.00	405.17	1,237.98	581.00
3	0.00	0.00	405.17	1,237.98	666.78
4	0.00	0.00	204.75	1,237.98	755.46
5	0.00	0.00	0.00	1,237.98	846.15
6	0.00	0.00	0.00	1,237.98	846.15
7	0.00	0.00	0.00	1,237.98	846.15
8	0.00	0.00	0.00	1,237.98	846.15
9	0.00	0.00	0.00	951.54	936.29
10	0.00	0.00	0.00	632.71	1,036.61
11	0.00	0.00	0.00	0.00	1,235.77
12	0.00	0.00	0.00	0.00	1,235.77
13	0.00	0.00	0.00	0.00	1,235.77
14	0.00	0.00	0.00	0.00	1,235.77
15	0.00	0.00	0.00	0.00	1,235.77
16	0.00	0.00	0.00	0.00	1,235.77
17	0.00	0.00	0.00	0.00	1,235.77
18	0.00	0.00	0.00	0.00	1,235.77
19	0.00	0.00	0.00	0.00	1,235.77
20	0.00	0.00	0.00	0.00	1,235.77

facilities make up the bulk of swine investments. Hence, efficiencies of the confinement system can be supported in Model V where high use over a long period of time occurs. Swine facilities are not replaced in year 11. Rather the enterprise organization changes to a crop based plan engaging in corn production as a cash crop. In contrast to Model I, no cattle feeding enters the optimal solution of Model V.

Model V generates a much higher level of cash crop activity compared to Model I. This is possible due to the absence of cattle production, hog production tending to occur in confinement facilities and no forage production. Thus, labor is released for greater levels of land-based enterprises.

CYCLICAL LIVESTOCK PRICE ANALYSIS

Previous analyses have been confined to determining optimal investment strategies under constant product prices. Adjustments in output of crops and livestock were found in response to the general farm growth strategy. The adjustments in output for livestock took place under moderate length 10-year swine and cattle facilities. Both shorter and longer term cattle facilities were investigated. The cattle facilities were used to their capacity for the 10 years and then rebuilt. Thus, little pressure existed for investment in shorter-term cattle facilities. The 20-year cattle facility was not found to compete in its use of resources.

The reasons for which a farm firm makes short-term output adjustments, however, more likely are in response to product price changes rather than due to the general growth strategy. That is, as livestock prices change and under perfect knowledge of these changes, response to these changes might occur in terms of changing short-term livestock investments. Furthermore, it has been shown that under wide swings in product prices a flexible investment is economically more efficient than specialized investments (3).

Models VI and VII were developed to analyze investment behavior resulting from cyclical livestock prices. A flexible investment alternative for use in either hogs or cattle was included in addition to the livestock investment activities previously included in Models I–V. Therefore, this part of the analyses was directed at determining if past livestock price variations have been wide enough to select short-term livestock investments or flexible livestock investments compared to specialized livestock investments.

The livestock price assumptions for Models VI and VII are shown in Table 3. The 10-year cattle price cycle was repeated twice; the 5-year hog price cycle was repeated four times over the period. Model VI used 1959 cattle prices and 1964 hog prices as starting prices representing initially high cattle and low hog prices. In Model VII 1963

Table 14. Cattle and hog price assumptions: Models VI and VII.

Year	Model VI		Model VII	
	Fat steers	Market hogs	Fat steers	Market hogs
	($ per cwt)	($ per cwt)	($ per cwt)	($ per cwt)
1	27.51	15.24	23.37	17.70
2	25.76	20.99	22.42	15.24
3	24.27	23.25	25.32	20.99
4	27.14	19.17	25.65	23.25
5	23.37	17.70	25.22	19.17
6	22.42	15.24	27.96	17.70
7	25.32	20.99	27.51	15.24
8	25.65	23.25	25.76	20.99
9	25.22	19.17	24.27	23.25
10	27.96	17.70	27.14	19.17
11	27.51	15.24	23.37	17.70
12	25.76	20.99	22.42	15.24
13	24.27	23.25	25.32	20.99
14	27.14	19.17	25.65	23.25
15	23.37	17.70	25.22	19.17
16	22.42	15.24	27.96	17.70
17	25.32	20.99	27.51	15.24
18	25.65	23.25	25.76	20.99
19	25.22	19.17	24.27	23.25
20	27.96	17.70	27.14	19.17
Avg.	25.46	19.82	25.46	19.82

cattle prices and 1968 hog prices were used as starting prices in the models representing initially low prices for both hogs and cattle. In each model the average of the cyclical livestock prices equals the average prices of Model V. Crop prices remained the same as for all models previously discussed. In Table 14 the livestock prices for Models VI and VII are shown by year.

The flexible livestock investment activity was a dual-purpose activity for use in cattle and swine farrow feeding. The flexible investment activity has associated cattle and hog activities which allow for yearly adjustments in the levels of hogs and cattle. The flexible activity is assumed to be a 10-year facility with a capital requirement of $48 per head of cattle or $240 per sow.

Model VI

The resource restrictions of Model VI parallel those of Model V. The results for Model VI may be compared with Model V since the only difference between models is the cyclical livestock price aspect of Model VI contrasted to the constant livestock prices of Model V.

Resource uses for the solution to Model VI are given in Table 15. Growth in owned cropland occurs in a pattern very similar to Model V. Large purchases of cropland in the first 11 years bring the level of

Table 15. Summary of resource use: Model VI.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
	(Dollars)	(Hours)	(Acres)	(Acres)
1	38,996.87	1,026.21	126.21	446.21
2	50,000.00	3,422.83	89.85	536.06
3	50,000.00	4,000.00	117.31	653.37
4	50,000.00	4,000.00	113.24	766.61
5	48,533.84	4,000.00	72.26	838.87
6	39,176.27	4,000.00	0.00	838.87
7	25,037.16	4,000.00	0.00	838.87
8	2,207.86	4,000.00	0.00	838.87
9	0.00	4,000.00	97.90	936.77
10	3,604.27	4,000.00	112.88	1,049.65
11	21,376.78	4,000.00	186.11	1,235.76
12	0.00	4,000.00	0.00	1,235.76
13	0.00	4,000.00	0.00	1,235.76
14	0.00	4,000.00	0.00	1,235.76
15	0.00	4,000.00	0.00	1,235.76
16	0.00	4,000.00	0.00	1,235.76
17	0.00	4,000.00	0.00	1,235.76
18	0.00	4,000.00	0.00	1,235.76
19	0.00	4,000.00	0.00	1,235.76
20	0.00	4,000.00	0.00	1,235.76

owned cropland to 1,236 acres, identical to Model V. As in Model V, no cropland was purchased in years 6, 7 and 8.

Capital borrowed and labor hired were similar between Models V and VI. The major difference between models was the lower levels of borrowed capital and hired labor in year 1 of Model VI reflecting less investment and operating activity in that year.

The organizational results of Model VI are shown in Table 16. Compared to Model V a slightly greater mix of production in Model VI is centered in hog production in the first half of the period. Correspondingly, less resources in Model VI are engaged in crop production in the first half of the period compared to Model V. No cattle are fed in Model VI, as was the case in Model V. As in Model V a ratio of about three to one of investments of confinement capacity to conventional capacity for swine occurred.

Overall, swine capacity is slightly greater in Model VI compared to Model V. The only significant difference between the two models centers on the timing of the swine investments. In Model V all swine investments take place in year 1 with a high usage rate for the 10-year life of the investments. In Model VI the swine confinement investment is delayed until year 2 accompanied by a slightly lower usage rate of the confinement system in later years of the investment compared to Model V. Thus, in response to the cyclical hog prices, adjustments in the timing, level and usage of swine investments occur.

The swine confinement investment of Model VI is delayed one year in response to a low initial hog price ($15.24). In years 9, 10 and 11

Table 16. Summary of livestock investments and crop and livestock activity levels: Model VI.

Year	Livestock investments		Livestock fed		Crops
	Conventional farrowing	Confinement farrowing	Hogs conventional farrowing	Hogs confinement farrowing	Corn
	(Sows)	(Sows)	(Head)	(Head)	(Acres)
1	27.03	0.00	418.96	0.00	445.94
2	0.00	81.59	418.96	1,264.49	534.98
3	0.00	0.00	418.96	1,264.49	652.29
4	0.00	0.00	163.21	1,264.49	765.53
5	0.00	0.00	0.00	1,264.49	837.79
6	0.00	0.00	0.00	1,264.49	837.79
7	0.00	0.00	0.00	1,264.49	837.79
8	0.00	0.00	0.00	1,264.49	837.79
9	0.00	0.00	0.00	953.40	935.69
10	0.00	0.00	0.00	594.73	1,048.58
11	0.00	0.00	0.00	2.48	1,234.96
12	0.00	0.00	0.00	0.00	1,235.77
13	0.00	0.00	0.00	0.00	1,235.77
14	0.00	0.00	0.00	0.00	1.235.77
15	0.00	0.00	0.00	0.00	1,235.77
16	0.00	0.00	0.00	0.00	1,235.77
17	0.00	0.00	0.00	0.00	1,235.77
18	0.00	0.00	0.00	0.00	1,235.77
19	0.00	0.00	0.00	0.00	1,235.77
20	0.00	0.00	0.00	0.00	1,235.77

(years 8, 9 and 10 of the investment life) relatively low hog prices occur encouraging the relatively low usage rate of the swine confinement investment of Model VI compared to Model V. A greater proportion of resources in Model VI are devoted to hog production compared to Model V because of the opportunity to time production to the price cycle. At the same time, because of lower initial activity in year 1, Model VI engages in hog production at a slightly higher rate than Model V because of the capital generating potential of hog production. In year 11 of Model V and year 12 of Model VI, organization is stabilized with 1,236 acres of cropland (corn).

Flexible facilities are not found to economically compete with the specialized hog facilities. This is partly because cattle feeding could not economically compete with hog production, hence no meaningful pressure to "switch" production from hogs to cattle occurred.

Model VII

Very small differences in resource use occur between Model VII and Model VI as can be seen by comparing Table 17 with Table 15.

Some differences in investment activity and enterprise organization exist between the two cyclical-price models. Table 18 displays the investment and organizational results for Model VII. As in Model VI and V, cattle feeding does not form part of the optimal organizational results. Hence, the only meaningful difference between Model

Table 17. Summary of resource use: Model VII.

Year	Borrowed capital	Hired labor	Land purchased	Total owned cropland
	(Dollars)	(Hours)	(Acres)	(Acres)
1	38,795.63	976.37	126.22	446.22
2	50,000.00	3,422.71	89.83	536.05
3	50,000.00	4,000.00	117.33	653.38
4	50,000.00	4,000.00	113.48	766.86
5	46,625.27	4,000.00	61.76	828.62
6	37,487.12	4,000.00	0.00	828.62
7	23,196.05	4,000.00	0.00	828.62
8	0.00	4,000.00	0.00	828.62
9	0.00	4,000.00	111.02	939.64
10	10,361.85	4,000.00	150.41	1,090.05
11	20,459.23	4,000.00	145.71	1,235.76
12	0.00	4,000.00	0.00	1,235.76
13	0.00	4,000.00	0.00	1,235.76
14	0.00	4,000.00	0.00	1,235.76
15	0.00	4,000.00	0.00	1,235.76
16	0.00	4,000.00	0.00	1,235.76
17	0.00	4,000.00	0.00	1,235.76
18	0.00	4,000.00	0.00	1,235.76
19	0.00	4,000.00	0.00	1,235.76
20	0.00	4,000.00	0.00	1,235.76

Table 18. Summary of livestock investments and crop and livestock activity levels: Model VII.

Year	Livestock investments		Livestock fed		Crops
	Conventional farrowing	Confinement farrowing	Hogs conventional farrowing	Hogs confinement farrowing	Corn
	(Sows)	(Sows)	(Head)	(Head)	(Acres)
1	25.54	0.00	395.87	0.00	445.97
2	0.00	83.69	395.87	1,297.20	534.96
3	0.00	0.00	395.87	1,297.20	652.29
4	0.00	0.00	139.50	1,297.20	765.78
5	0.00	0.00	0.00	1,297.20	827.54
6	0.00	0.00	0.00	1,297.20	827.54
7	0.00	0.00	0.00	1,297.20	827.54
8	0.00	0.00	0.00	1,297.20	827.54
9	0.00	0.00	0.00	944.42	938.56
10	0.00	0.00	0.00	466.40	1,088.97
11	0.00	0.00	0.00	26.35	1,234.94
12	0.00	0.00	0.00	0.00	1,235.77
13	0.00	0.00	0.00	0.00	1,235.77
14	0.00	0.00	0.00	0.00	1,235.77
15	0.00	0.00	0.00	0.00	1,235.77
16	0.00	0.00	0.00	0.00	1,235.77
17	0.00	0.00	0.00	0.00	1,235.77
18	0.00	0.00	0.00	0.00	1,235.77
19	0.00	0.00	0.00	0.00	1,235.77
20	0.00	0.00	0.00	0.00	1,235.77

VI and Model VII is the effect of the one-year difference in the position of the hog price cycle. This causes a "downswing" in hog prices in years 1 and 2 where in Model VI the price cycle had begun its "upswing." Some minor adjustments take place in response to this difference in hog price assumptions.

The general pattern of conventional swine facility investments in year 1 and confinement swine facility investments in year 2 remains the same between Models VII and VI. A larger overall swine capacity investment occurs in Model VII compared to Model VI. In addition a greater proportion of resources are directed to confinement facilities over conventional facilities. This change may be explained by the occurrence of lower average hog prices during the first four years of the period under Model VII compared to Model VI. Thus, resources are directed from the less used conventional swine facility to the confinement swine facility. Through some released labor because of the confined swine system a greater production of hogs occurs under Model VII over Model VI. Cropland (corn) levels are very similar between Models VII and VI. As in Model VI, no resources were committed to flexible livestock investments in response to the livestock price cycles.

CONCLUSIONS

The optimal growth pattern for eastern Nebraska grain-livestock farms is:

1. Initially large swine investments, and hog production.
2. A phase-out of hog production toward accumulation of owned land.
3. An increase in cattle feeding capacity, depending upon price assumptions.
4. In the event cattle feeding becomes part of the optimum growth strategy, decrease in accumulation of owned cropland.

When resource restrictions are altered, some pronounced effects on the optimum growth strategy are observed.

With capital restricted (Model II) larger hog production takes place early in the period for purposes of capital generation.

With hired labor restricted (Model III) the high labor-requiring hog enterprise is eliminated from the solution in favor of some growth in cattle production during the middle part of the period.

When initial owned land is put at 80 acres compared to 320 acres (Model IV) very high levels of hog production occur. Under this restricted land option, cattle production is delayed although eventually reaching a level comparable to the first two models.

Of all resource changes examined, change in labor availability affected growth strategy most greatly.

Model V was analyzed so as to examine the effect of varying product prices as optimal growth strategies. Under slightly lower livestock prices the optimal growth strategy was directed at higher hog production and greater land purchases compared to Model I. Cattle feeding did not form any part of the growth solution for Model V. Hog production acts as an efficient capital generating tool in growth plans. Also, cattle feeding tends to compete with cash crop farming in mid and later periods of optimal growth plans.

In Models VI and VII cyclical hog and beef prices are programmed and the results may be compared to Model V. Under the cyclical variations in livestock prices assumed, it was found that the general growth strategy was very similar to the growth strategy under constant prices. Some minor adjustments to price changes were observed in terms of livestock investments and organization.

Cyclical variations in livestock prices did not lead to investments in flexible livestock facilities. Rather, the result was continued investments in specialized swine facilities.

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